

# Chemical Properties and Mineralogical Composition of Soils in Original site at Coal Mining Area, East Kalimantan

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**ABSTRACT** : Soil minerals and chemical properties play an essential role in agricultural, especially to know the availability of soil nutrient reserve. The objective of the study was to investigate soil chemical properties and mineralogical composition of sand fraction in original area. The study was conducted in two stages. The First stage was in the field and the second stage was in the laboratory. The field study was at Original area PT. Khotai Makmur Insan Abadi, Kutai Kartanegara, East Kalimantan. Soils were sampled from each horizon of the profile. The second stage was in the Laboratory. The chemical analysis was conducted in the Soil Laboratory, Agriculture Faculty, Mulawarman University. The Mineralogical composition of fine sand fractions was conducted in Pusat penelitian tanah Bogor, with *line counting* method using Microscope Polaritation (MP). The results of chemical characteristics indicated that low to very low content of organic matter, soil reactions are acid throughout the horizon, very low to moderate base saturation, low to moderate soil cation exchange capacity, high of Al saturation. Sand fraction composition was dominated by resistant minerals (quartz and opaque). On the other hand the easily weatherable minerals are not detected in the original area. One of the reason soil has low CEC is, because the composition of sand fraction in the soil dominated by quartz.

**Keywords** :Chemical Properties, Mineralogical composition, Microscope Polaritation, Quartz, Sand Fraction.

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## INTRODUCTION

Soil chemical properties have strong association with primary minerals composition. The composition of primary minerals influences chemical properties, particularly in soil management practices (Anda *et al.* 2012).

Soil Minerals are important substance in soil formed, from cooling magma. According to Allen and Fanning (1983), the mineral components of many soils are inherited almost from the parent material.

Quartz is most abundant several varieties of silica glass (Wilding *et al.*

1977), one of the most resistant minerals. It is present in sand and silt fractions.

Feldspars belong to the group of Minerals, divided into orthoclase and plagioclase. The primary minerals in East Kalimantan consist of easily weatherable minerals (feldspar hornblende, plagioclase, olivine, pyroxene, amphibole volcanic glass), and resistant weatherable minerals such as quartz and opaque (Prasetyo *et al.* 2001; Anda *et al.* 2012; Pramuji and Bustaman, 2009). Primary minerals (sand fractions) are formed by physical weathering of the rocks. Primary minerals have been components of previously existing soils (Allen and

Fanning, 1983).

The mineralogical and chemical studies have been characterized by some researches (Anda *et al*, 2012; Ohta *et al*, 1992, Anda *et al*, 2016); Prasetyo *et al*, 2001, Prasetyo and Suriadikarta, 2006); Sanchez *et al* (2019); Pramuji and Bastaman, 2009; Prasetyo, 2007); Portela *et al* (2019), however, it's still no detailed information on the soil of Kutai Kartanegara, East Kalimantan, specially original area at PT. Khotai Makmur Insan Abadi. The purpose of the current study was to determine the chemical properties and mineralogical composition of sand fractions in original area at PT. Khotai Makmur Insan Abadi, Kutai Kartanegara, East Kalimantan.

## MATERIALS AND METHODS

### Study Area

The major study field was selected in the PT. Khotai Maksur Insan Abadi, Kutai Kartatenagara, Province of East Kalimantan was at original area (nursery area). The original (Nursery) area at PT. Khotai Makmur Insan Abadi, Kutai Kartanegara covering  $\pm 1.31$  ha.

The study was conducted for 5 months from April to September 2019. Four soil sampled from each horizon of profil (  $00^{\circ} 14' 02,6''\text{S}$ - $117^{\circ} 06'44,4''\text{E}$ ) in original (nursery) area at PT. Khotai Makmur Insan Abadi, Kutai Kartanegara, East Kalimantan.

### Analytical Method

#### 1. Chemical Analysis

The 500g of soil sampel from each horizon for chemical analysis. Analysis was conducted at Soil Laboratorium, Agriculture Faculty, Mulawarman University.

Data analysis consists of texture, pH ( $\text{H}_2\text{O}$ ) was measured by the glass electrode method on 1 : 2.5 soil:water, CEC ( cation exchange capacity) using 1 N ammonium acetate ( $\text{NH}_4\text{OAc}$ ) at pH 7.0 as an extractant, organic carbon (Walkley and Black Method, using spectrophotometry), Base Saturation (%) was expressed by the percentage of sum of Ca, Mg, K and Na in 1 N ammonium acetate ( $\text{NH}_4\text{OAc}$ ) at pH 7.0.

#### 2. Mineralogical analysis

The 500 gr of oil sample representing each horizon was taken for mineralogical of the sand fractions analysis. The soil samples were destruction with  $\text{H}_2\text{O}_2$  (30%) and HCL (10%). The mineralogical compositions of sand fractions of soils were analyzed at Laboratory of Mineral (BB Litbang SDLP), Bogor, using a polarizing microscope (PM).

## RESULTS AND DISCUSSION

### Composition of The sand fraction Minerals

Based on fine sand fractions analysis using a polarizing microscope (PM), composition of minerals in sand fractions of soil profile from original (nursery) area at coal mining is given in Table 1. The finding provides evidence that primary mineral composition of soils dominated by resistant minerals are quartz and opaque. The composition of Quartz (84-86%), opaque (1-4%), Zirkon (1-3%), weathered mineral ( 3-6%), rock fraction (1-2%). Quartz is the most stable mineral (Rajamuddin *et al*, 2013). The resistant minerals have no potential reserved nutrients in the soil

(Anda *et al*, 2012). On the other hand the composition of weatherable minerals such as feldspar, mineral group, ferromagnesian mineral group which is potential sources in reserved nutrients are not found.

### Soil Properties

Some chemical properties of soil in original area at PT. Khotai Makmur Insan Abadi, i.e., pH (H<sub>2</sub>O), texture (particle size), organic carbon, base saturation, cation exchange capacity (CEC), exchangeable cation, Al saturation, available P are shown in Table 2 and 3.

Table 1. Mineralogical composition of fine sand fractions (50-250µm)

Depth (cm)	Op	Zi	Qt	Wm	Rf	Vg	Og	Bw	An	Or	Sn	An	Hb	Au	En	Total
0-25	1	3	85	5	1	-	-	-	-	-	-	-	-	-	-	100
25-60	4	1	86	4	1	-	-	-	-	-	-	-	-	-	-	100
60-90	2	1	84	6	-	-	-	-	-	-	-	-	-	-	-	100
90-120	3	2	85	3	2	-	-	-	-	-	-	-	-	-	-	100

-= not detected, Op=Opaque, Zi=Zirkon, Qt=Quartz, Wm=Weathered mineral, Rf=Rock fragment, Vg=Volcanic glass, Og=Oligoclase, Bw=Bytownite, An=Anorthite, Or=Orthoclase, Sn=Sanidine, An=Andesine, Hb=Hornblende, Au=Augite,, En=Enstatite

As illustrated in Table 2, the topsoil texture showed that the particle size class is loam, with 24.38% clay, 29.76 % silt, and 45.86% sand fraction. The subsoil has clay content varying from 26.87 to 36.39%, the silt fraction varying from 22.27 to 36.62% and sand fraction content varying from 26.99 to 50.86%. The sub soil texture varies from clay loam to sandy clay loam. This means that the topsoil contains a lower content of clay than the subsoil.

The cation exchange capacity (CEC) of soil from the the topsoil to the subsoil content varying from low to moderate (14.48-21.64 me/100g). Cation

exchange capacity is affected by soil pH. From topsoil to subsoil the soil pH in H<sub>2</sub>O acid (4.64-4.57). The reason for low of CEC in both topsoil and subsoil is because the clay content in topsoil and subsoil is lower than sand content.

The organic carbon from the topsoil to the subsoil showed low ( 1.18%) to very low (0.40-0.97%). The organic carbon content in the subsoil is always lower than in the topsoil. Organic carbon content in soil can affects another soil properties, specifically cation exchange capacity (CEC).

Table 2. pH, CEC, Organic-Carbon, Base Saturation, Particle Size

Horizon	Depth	pH	CEC	Organic-C	Bases Saturation	Particle Size		
		H <sub>2</sub> O	me/100g	%	%	Clay	Silt	Sand
	(cm)						%	
A	0-25	4.64	16.35	1.18	41.30	24.38	29.76	45.86
B1	25-60	4.62	14.48	0.84	30.27	30.66	32.79	36.55
B2	60-90	4.60	21.64	0.97	26.98	26.87	22.27	50.86
B3	90-120	4.57	18.87	0.40	18.93	36.39	36.62	26.99

Table 2 provides that base saturation in the surface horizon content moderate (41.30%), in the subsoil base saturation varies from low to very low (30.27 - 18.93%). Base saturation in the topsoil is higher than in the subsoil. This is similar to the result of study by Prasetyo *et al* (2001) who finds that the base saturation of top soil is slightly higher than subsoil.

As Table 2 present the pH of both soils, topsoil and subsoil, was acidic (H<sub>2</sub>O-pH 4.57 - 4.64). High level of measurable acidity are connected with the low base content in soil (Miller, 1983). Soil reaction are highly related to base saturation, it influences the base saturation, soil with low pH generally has low base saturation, the higher the Soil pH leads to the higher base saturation (Hardjowigeno, 2003).

Table 3. Al Saturation, Available P, Cations Exchange

Horizon	Depth	Al Saturation	Av. P	Exchangeable Cation (pH 7)					
		%	Bray ppm	Ca++	Mg++	K+	Na+	Al+++	H+
	(cm)			meq/100g					%
A	0-25	30.57	19.49	4.01	2.06	0.49	0.2	5.00	4.60
B1	25-60	37.97	19.08	3.82	0.09	0.35	0.13	5.50	4.60
B2	60-90	43.44	15.71	2.48	3.12	0.22	0.02	9.40	6.40
B3	90-120	40.80	12.96	2.10	1.19	0.24	0.04	7.70	7.60

The results of other chemical properties of the original area i.e., exchange acidity (Al and H), exchangeable bases (Ca, Mg, K, Na), Available P and Al saturations are presented in Table 3.

From Table 2 and 3, we can see that the available P are high, the amount of exchangeable bases at the exchange complex is associated with base saturation. If high content of exchange

acidity, the low content of exchangeable bases, and Al saturation will high. Al saturation is also connected with amount of Al cation. It indicates that if Al saturation is high, then a lot of amount of Al cation at the exchange complex or base saturation is low.

According to Prasetyo *et al* (2001), high Al saturation affects Al toxicity which influence problems for crop growth, and to alleviate Al toxicity by liming the soil with agricultural lime or using more organic matter.

### CONCLUSION

Soils have loam texture in the topsoil while in the subsoil exhibits clay loam and sandy clay loam particle size class. Organic carbon is moderate in the top soil dan very low in the subsoil. Soil reaction is acid (4.6) throughout the horizon. Base saturation in the topsoil is moderate, and low to very low in the subsoil. Cation exchange capacity (CEC) are low to moderate. Al saturation are high, and available P are high to very high. The fine sand fraction is composed of quartz. Low chemical properties and high composition of resistant minerals (quartz) in the soil, indicate that soil has limited nutrient reserve or soil has low fertility.

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